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A SHORT TERM STUDY OF ALGAL FLORA OF A SALT PAN NEAR CHENNAI

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ABSTRACT

Halophilic algae were collected from Kelambakkam salt pan which is situated in the outskirt of Chennai, and they were identified. A total number of 16 taxa were reported, of these 4 taxa belong to the class Cyanophyceae, 2 to Chlorophyceae, and 10 belong to Bacillariophyceae. During the study period, it was observed that the species diversity has decreased sharply when the salinity of the water increases. In the high saline region i.e. in the crystallizing area only the species of *Dunaliella* and *Nitzschia closterium* were seen. *Dunaliella salina* was the most prominent species in the crystallizing area forming orange-red patches on the salt crystals. When the algae were cultured under laboratory condition, most of the species were failed to grow except *Oscillatoria salina* and *Dunaliella* sp.

INTRODUCTION

'Algae' is an historical and practical grouping of generally photosynthetic organisms of simple construction. It includes a diverse array of morphologies from single cell to large, multicellular organisms. They can be found in either fresh water or marine habitats. The distinction between marine and fresh water habitats is revealed in the variety of algae that occur in these environments. There are no exclusively freshwater divisions of algae, but certain groups exhibit greater abundance and diversity within fresh waters, especially the members of Cyanophyceae, Chlorophyceae, and Charophyceae (Smith, 1950). Within the green algae, conjugating greens and desmids (Zygnematales) comprise a rich collection of species that almost exclusively occupy fresh water. Other groups such as the diatoms and Chrysophytes are well represented in both spheres. Members of the divisions particularly the Phaeophyta, Pyrophyta, and Rhodophyta, exhibit great diversity in marine waters (Smith, 1950; Bourrelly, 1985). In addition, certain species occur in great abundance in and on soil, on logs, and tree trunks, on rocks, on snow and ice, in various associations with other plants as well as animals and in many apparently unusual places. Perhaps no other group of plants, except the bacteria is able to grow in such diverse environmental condition. Whatever the habitat, algae are dependent upon factors such as light, oxygen, carbon dioxide, proper temperatures, water and suitable mineral salts. Algal growth suffers from the inadequacy of any of these factors. The technical term for saltines in the ocean is salinity, traditionally expressed as parts per thousand (ppt or ‰) which is approximately grams of salt per liter of solution. Based upon the salinity, water bodies are classified in to the following types; Marine waters are those of the ocean, another term for which is euhaline seas. The salinity of euhaline seas is 30 to 35‰. Brackish (seas) waters have salinity in the range of 0.5 to 29‰ and metahaline seas from 36 to 40‰. These waters are all regarded as thalassic, because their salinity is derived from the ocean and defined as homoiohaline. In contrast to homoiohaline environments there are others such as poikilohaline environment in which the salinity variation is biologically significant. Poikilohaline water salinities may range anywhere from 0.5 to greater than 300 ‰. The important characteristic is that these waters tend to vary in salinity over some biologically meaningful range seasonally or on some other roughly comparable time scale. Highly saline water, from which salts crystallize or are about to, is referred to as brine or saltern.

Salinity is an ecological factor of considerable importance, influencing the type of organisms that live in a body of water. Any life form adapted to saline condition is classified as halophiles. Halophilic species of algae have been reported from brine lakes, salterns, salt springs and pools with a saline content two to seventeen times that found in the ocean. The algae of such salty waters found widely distributed throughout the world, are largely Chlorophyceae, although there occur species of Myxophyceae, Bacillariophyceae and Euglenophyceae (Tiffany, 1938). *Dunaliella* reported from numerous brine water is probably the most common of the green algae. *Chlamydomonas ehrenbergii* has been found in the saline lakes of Crimea. In Searles Lake, California, both *Dunaliella* and *Stephanoptera* form light green areas on solid salt crusts where the water has a concentration of 33 % dissolved solids (Smith, 1950). Certain diatoms can withstand

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great changes in salinity, and several species of diatoms such as *Amphiprora, Anomoeoneis, Caloneis, Campylodiscus, Cyclotella Cymbella, Navicula, Pleurosigma, Surirella*, and *Tropidoneis* has been reported from saline Pyramid Lake in Nevada (Hanna and Grant, 1931; Smith, 1950).

Hof and Fremy (1933) reported blue green algae such as *Microcoleus chthonoplastes* and *Lyngbya estuarii* found between the salt layers and the soil of solar salt works. They find varying degrees of tolerance among the species of the blue green algae to salt concentrations, and reported *Aphanocapsa littoralis, Spirulina subsalsa* and *Phormidium tenue* growing and multiplying in solutions more concentrated than three molar sodium chloride (about 175 ‰). Under hypersaline conditions (20-600 ‰), diversity is very low, and includes some species that are restricted to higher salt levels, such as the diatoms *Amphora coffeaeformis, Anomoneis, Sphaerophora, Navicula subinflatoides; Nitzschia communis* and *Nitzschia frustulum,* Cyanobacteria *Nodularia spumigena* and *Aphanothece halophytica* (Blinn, 1971; Herbst and Bradley, 1989; Wurtsbaugh and Berry, 1990; Kociolek and Herbst, 1992; Reuter *et al*., 1993). In Tamil Nadu although considerable work has been done on the ecology of fresh water algae as well as marine algae, no much work has been done on the ecology of the halophilic algae. In the present investigation an attempt has been made to study the diversity of algae in a salt pan near Chennai.

MATERIALS AND METHODS

The present study was done in Kelambakkam salt pan which is situated in the outskirt of Chennai, coming under Kancheepuram district, about 17 kilometers away from Tambaram. Kelambakkam has 1300 acres of salt pans, out of which 130 acres are used as crystallizing area. The seawater which has 30 ‰ concentration is extracted from the Bakingham canal area and stored in a reservoir for about 45 days, up to 250 ‰. The reservoir occupies for about 520 acres of land. 30 % of land is used as a condenser, which is 390 acres of land. Final condenser is about 20 % of the land for storing water before passing it on crystallizing area. Later this water is let out into the crystallizing area which is allowed to sediment for about 15 days. Only when the salt concentration in the water is 250 to 280 ‰ will the salt be able to crystallize. Finally the crystallized salt is scraped out and each crystallizing segment brings about 4-8 tones of salts.

Samples were collected from condenser as well as crystallizing area once in every 15 days interval for a period of three months from January 2008 to March 2008 by scrapping out the algae with the help of a scalpel from the salt crystals and from other hard substratum and brought to the laboratory in small plastic containers for examination. For plankton collection, one liter of water sample was also collected separately from the locality to which 10ml of Lugol's iodine solution was added (to get the final concentration of 1%) and left undisturbed for about 24 hours. The planktons fixed and settled at the bottom of the container were collected and preserved in bottles containing 4% formalin glycerin preservative after decanting the supernatant fluid. All the samples were serially numbered, labeled with date and place of collection. Samples after examination are deposited in the Laboratory of Phycology, Department of Plant Biology and Plant Biotechnology, Madras Christian College, Tambaram, Chennai - 600 059. Since cultivation is usually necessary for detailed taxonomic studies of algae, the morphology of the species was therefore studied both from the field collected materials and from cultured specimens. Part of the fresh field material was aseptically inoculated in to sterilized, liquid, modified Chu-10 medium (Gerloff *et al*., 1950) prepared using seawater. The cultures were grown at room temperature and illuminated with two cool white fluorescent lamps providing an irradiance of 20 $\mu E/m^2/s$ in a 16:8 light dark regime and they were examined with in 7-21 days of incubation. Algal samples were examined immediately after collection and also from the cultured medium using calibrated student's research microscope and measurements were taken. They were identified using standard algal monographs and publications of Venkataraman (1939), Subrahmanyan (1946), Krishnamurthy (1954), Desikachary (1959), Iyengar and Desikachary (1981) and Compere (1990).

RESULTS AND DISCUSSION

A total number of 16 taxa were identified, of these 4 taxa belong to the class Cyanophyceae, 2 to Chlorophyceae, and 10 belong to Bacillariophyceae. The descriptions of the taxa of algae collected during the present study are given below.

CYANOPHYCEAE

***Oscillatoria salina* Biswas**

Plant mass forming a deep blue-green thin membrane extending over the muddy soil on the field. Trichome straight, elongate, erect, scarcely curved, fragile, rapidly moving, not constricted at the joints, 4 µm broad, apices of trichome straight, briefly tapering ending acuminately in a sharp point, hooked or twisted, not capitate; apical cell mucronate hyaline, calyptra absent; cells shorter than broad, 1.5 µm long, transverse septa indistinct, not granulated, cell contents finely uniformly granular, almost homogeneous, blue-green.

Habitat: On muddy soil, collected on 15.01.2008, bottle No: V03

Distribution: Reported from salt lake and in river Hoogly, Calcutta; and on moist soil, Benaras (Desikachary, 1959).

***Spirulina subsalsa* Oerst. ex Gomont**

Trichomes 2-5 µm broad, blue green to yellowish green, somewhat irregularly densely spirally coiled. Occurs single among other algae as planktonic, spirals very close to each other.

Habitat: On muddy soil, occurred in all the collections, bottle No: V02.

Distribution: Reported from Calcutta, Hydrabad, Andhra Pradesh, Berhampur in Orissa, sea shore in Bombay, in salt

pans of Tirupati, and on wet soil in Madras, as well as in brakish water ponds in Ceylon (Desikachary, 1959).

***Synchocystis* sp.**

Cells spherical, single or two together after division, 3-4 µm broad, without distinguishable mucilage envelopes.

Habitat: Planktonic form, collected on 30.01.2008, bottle No: V02.

Distribution: Only two species of *Synechocystis* i.e. *S. aqualitis* and *S. pevalekii* were reported from India, the description of both and the measurement of the cells do not agree with our specimen.

***Chroococcus turgidus* (Kuetz.) Nag.**

Cells spherical to ellipsoidal, single or in groups of mostly 2-4, rarely many, in a gelatinous or mucous matrix; sheath of individual cells distinct, firm, colourless, not distinctly lamellated, in some, homogeneous, persistently or irreglularly broken. Usually blue-green, some times olive green to yellowish green. Cells without sheath 8.5-30 µm, with sheath 13-35 µm.

Habitat: On bottom of the muddy water as well as planktonic, collected on 15.10.2008, bottle No:V01.

Distribution: This alga was previously reported from Lahore in Pakistan as a planktonic sample in mangroves, attached to submerged parts, subaerial on tree trunks, also from Bombay and Calcutta (Desikachary, 1959).

CHLOROPHYCEAE

***Dunaliella* sp.**

Cells globular, naked, 20-30 µm in diameter, with two anteriorly inserted flagella; Chloroplast single, cup-shaped without carotenoid pigments.

Habitat: Occurred as planktonic form, present in all the collections, bottle No: V02.

***Dunaliella salina* Teod.**

Cells naked, 12-21 µm long and 6-12 µm broad, broadly ovoid, ellipsoid or cylindrical with a constriction in the middle, often tapering acutely at the apex, posterior rounded; flagella two equal, anteriorly placed. Chloroplast single cup-shaped with lot of carotenoid pigments; pyrenoid single located in the basal part of the chloroplast.

Habitat: Forming red colour patches on the salt crystals as well as occurred as planktonic, present in all the collections, bottle No: V02.

Distribution: Reported from all over the world in the salt pans and brine lakes (Smith, 1950; Iyengar and Desikachary, 1981).

BACILLARIOPHYCEAE

***Amphora coffeaeformis* Agardh**

Frustules in girdle view elliptic lanceolate, truncate. Valves arcuate on the dorsal margin and straight or slightly concave on the ventral margin. Ends of the valves slightly protected and capitate. Striae delicate. Length 35 µm and breadth 10 µm.

Habitat: On muddy soil, collected on 15.01.2008, bottle No: V03.

Distribution: Reported from various places from Cooum estuary, Adyar estuary and Ennore backwater, Madras (Venkataraman, 1939).

***Cymbella* sp.**

Valves lunate with highly convex dorsal side and smooth ventral margin and acute ends. Raphe straight, terminal fissures turned downwards, axial area somewhat broad. Striations radial in the middle and slightly convergent at the ends on the ventral side, punctate. Length 22.5 µm and breadth 7.5 µm.

Habitat: On muddy soil, collected on 02.02.2008, bottle No: V03.

***Mastogloia dolosa* Venkataraman**

Valves elliptic lanceolate, axial area narrow, central area big, rectangular. In conjunction with the two longitudinal hyaline furrows form H-shaped figure. Striations transverse in the middle, radial towards the ends very finely punctuate. Length 40.5 µm and breadth 12.5 µm.

Habitat: On muddy soil, collected on 15.01.2008, bottle No: V03.

Distribution: Reported from Adyar estuary, Madras (Venkataraman, 1939; Krishnamurthy, 1954).

***Achnanthes brevipes* Ag. var. *intermedia* (Kuetz.) Cleve**

Valves linear with rounded ends, constricted in the middle in the hypotheca and the constriction not seen in the epitheca. The pseudoraphe straight and coarse in the middle. Rows of punctae more radial towards the poles. Length 37.5 µm and breadth 10.5 µm.

Habitat: On muddy soil, collected on 02.02.2008, bottle No: V03.

Distribution: Reported from Adyar estuary, Madras (Venkataraman, 1939; Krishnamurthy, 1954).

***Nitzschia closterium* (Ehr.) W. Smith**

Valves spindle shaped in the middle, ends extended in to long beaks usually slightly bent or curved in opposite directions, striation not visible. Length 22.5 µm and breadth 7.5 µm.

Habitat: Occurred as planktonic form, present in all the collections, bottle No: V03.

Distribution: Reported from coastal waters all over the world and in brackish waters in Madras (Venkataraman, 1939; Subrahmanyan, 1946).

***Nitzschia sigma* (Kutz.) W. Smith**

Valves linear, slightly sigmoid in girdle view; in vale view almost straight, considerably diminished in size at the extremities and elongated. Length 120 µm and breadth 13 µm.

Habitat: On muddy soil, collected on 17.02.2008, bottle No: V03.

Distribution: Indian Ocean (Subrahmanyan, 1946).

***Nitzschia stompsii* Choln.**

Valves linear areolae arranged in longitudinal striae, as in *N. sigma* but the valves are not sigmoid. Length 68 µm and breadth 10.5 µm.

Habitat: On muddy soil, collected on 03.03.2008, bottle No: V04.

Distribution: Reported from hypersaline inland waters of Egypt (Compere, 1990).

***Pinnularia viridis* (Nitzsch) Ehr.**

Valves linear with slightly convex and rounded ends, raphe complex. Axial area narrow, slightly widened in the middle. Striae coarse, slightly radial in the middle and convergent at the ends. Length 72.5 µm and breadth 12.5 µm.

Habitat: Occurred as plantktonic form, present in all the collections, bottle No: V04.

Distribution: Reported from Elliot beach, Madras (Subrahmanyan, 1946).

***Pleurosigma elongatum* W. Smith**

Valve slightly sigmoid, elongated, gradually attenuate, ends acute. Raphe central, slightly sigmoid. Length 160 µm and breadth 23.5 µm.

Habitat: Occurred as plantktonic form, present in all the collections, bottle No: V03.

Distribution: Reported from Atlantic coast of America, Java Sea, hypersaline inland waters of Egypt and from coastal waters in Madras (Subrahmanyan, 1946; Compere, 1990).

***Skeletonema costatum* (Greville) Cleve**

Frustules weakly silicified, lens shaped with rounded ends forming long slender straight chains with the aid of marginal spines which run parallel to the axis of the chain. Space between cells longer than the cells. Diameter of the cells 7 .5 µm.

Habitat: Occurred as planktonic form, collected on 03.03.2008, bottle No: V04.

Distribution: One of the commonest marine diatoms, found in the Arctics as well as in the tropics, reported from the Madras coast (Subrahmanyan, 1946).

During the various collection period of the study, it was observed that the species diversity was decreased sharply when the salinity of the water increases. Under low salinity, especially in the condenser area, the water sample contained almost all the above reported organisms, whereas in the high saline region i.e. in the crystallizing area only the species of *Dunaliella* and *Nitzschia closterium* were seen. *Dunaliella salina* was the most prominent species in the crystallizing area forming orange-red patches on the salt crystals. When the water samples were inoculated on sterilized liquid modified Chu-10 medium and cultured under laboratory condition, most of the species were failed to grow except *Oscillatoria salina* and *Dunaliella* sp. Further investigation is needed to find out the inefficiency of growth of other organisms.

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